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ABSTRACT

An educational digital environment that will provide appropriate methods and techniques for the support and enhancement of the educational and learning process is a valuable tool for both educators and learners. In the context of such a mission, the educational tool SL-EDGE (Student Library-Educational DiGital Environment) has been developed. The application employs, amongst others, a standardized metadata structure and collaborative filtering techniques in order to provide a set of educational services oriented towards users' needs for the discovery and reuse of educational resources for a reliable, efficient and effective assessment and also for communication, distribution and exchange of ideas and opinions. To this effect, it consists of two main modules: an educational digital library and an assessment tool for teachers and students. All the functions implemented are fully Web-based and the application deploys technologies, such as Java, JavaServer Pages and JavaBeans, transforming it to a powerful and robust educational tool. (Contains 30 references.) (Author)

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The Instructional Instrument SL-EDGE
Student Library-Educational DiGital Environment

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Abstract: An educational digital environment that will provide appropriate methods and techniques for the support and enhancement of the educational and learning process is a valuable tool for both educators and learners. In the context of such a mission, the educational tool SL-EDGE (Student Library-Educational DiGital Environment) has been developed. The application employs, amongst others, a standardized metadata structure and collaborative filtering techniques in order to provide a set of educational services oriented towards users' needs for the discovery and reuse of educational resources for a reliable, efficient and effective assessment and also for communication, distribution and exchange of ideas and opinions. To this effect, it consists of two main modules: an educational digital library and an assessment tool for teachers and students. All the functions implemented are fully web-based and the application deploys technologies such as Java, JavaServer Pages and JavaBeans, transforming it to a powerful and robust educational tool.

Keywords: digital library, assessment, metadata, standards, collaborative filtering, education.

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Introduction

The Internet and its software applications have become the de-facto information access and distribution system of the new millennium. However, the exponential growth of the World Wide Web and the continual augmentation of the available information resources have resulted to many problems due to the lack of standardized structures and typologies for content description. Moreover, the coverage of Web content by search engines is continually decreasing, and the full-text approach to searching has become increasingly ineffective due to the rise in non-textual information online. As a result, the search engine approach generally suffers from low precision and problematic information retrieval.

To address these problems, much recent research has focused on building web-based digital libraries containing vast repositories of information resources. Within educational applications, a primary goal of these libraries is to provide users (teachers and students) with a way to search for and display digital learning resources commonly called "learning objects". Examples of such educational digital libraries include the instructional system for the science, mathematics, engineering and technology education SMETE community (Dong et al., 2001), the open-source digital library software Greenstone (Witten et al., 2001), the Digital Libraries Initiative Project by the University of Illinois (DLI), the Libraries Special Collections Project by the North Carolina State University (LSC), the Pennsylvania Education Network Digital Object Repository (PEN-DOR) system by the University of Pittsburgh (Fullerton et al., 1999) and many more.

As part of these efforts, researchers are developing digital library systems that provide descriptive summaries intended to convey the semantics of an object. Together, the data elements of these summaries usually comprise what is called a metadata structure. Hence, in typical educational digital library applications, learning objects are stored and labeled with a metadata record. This metadata record usually contains basic

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information about the object including, for instance, technical requirements, rights management, and author details. Metadata structures are searchable and thus provide a means for discovering, sharing, and reusing learning objects, even when these objects are non-textual.

In this paper, we examine key assumptions underlying the design of an educational digital library coupled with a metadata structure and we demonstrate an implementation of the ideas discussed above within a system called SL-EDGE (Student Library-Educational DiGital Environment). In particular, we present the fundamental notion according to which a learning object can be effectively described with metadata elements and then retrieved via these descriptions in order to be used or reused in a new learning context.

As far as the effective description of learning objects is concerned, we argue that this incorporates the use of an appropriate metadata structure that will describe the semantics of a learning object and will also ensure the desired syntactic and semantic interoperability among other similar applications. Many efforts have been accomplished by organizations, groups and committees for the creation of standardized metadata element sets, which can offer these important capabilities to the applications that use them. The most important efforts include ADL organization (ADL) with SCORM specification (SCORM), ARIADNE project (ARIADNE) with a corresponding specification (ARIADNE version 3.1), CEN/ISSS Learning Technology Workshop (CEN/ISS), IEEE Learning Technology Committee (IEEE) with the Learning Object Metadata specification (LOM), IMS Global Leaning Consortium (IMS), ISO Joint Technical Committee (JTC1) SC36 (SC36) and many more. These efforts focus on issues such as controlled vocabularies, architecture, educational activities, metadata for learning objects, systems for course administration and technologies for student and teacher communication, cooperation and collaboration. The metadata structure used by SL-EDGE complies with the metadata element set that has been established by the Dublin Core Metadata Initiative (DCMI), a group of scientists that are responsible for the development, standardization and promotion of the corresponding Dublin Core Metadata Element Set (DCMES)(Baker, 2000).

We also argue that the semantic information about each learning object captured by the metadata structure described is critical in supporting effective discovery and reuse of learning objects for instructional purposes. A mechanism that uses this information in order to offer extended search capabilities, using expanded queries and corresponding browsing facilities, should be and is indeed provided by our application.

Furthermore, the application captures information about the users and their preferences, which is further exploited by a suitable collaborative filtering algorithm. We describe and discuss the application of a collaborative filtering technique in order to support automatic filtering and recommendation of relevant learning objects for SL-EDGE and we illustrate how the information about a learning object can be comprised of community-contributed information as well as usage metrics. This approach supports the automatic recommendation of relevant learning objects and allows the user to locate other users with whom shares similar interests for further communication and collaboration. The result is the creation of communities through evaluating and using learning objects and the reinforcement of the reusability of the learning objects.

As an essential and supplementary tool for the educational digital library with the above characteristics, an assessment module has also been introduced. Its purpose is to complete the learning procedure and provide evidence of good implementation of teaching methods and teachers' practices and of the overall comprehension and understanding of a certain educational domain on behalf of the students.

In the next sections we will discuss in detail the two modules presented above, the procedures they include, the practices they implement and the benefits they provide to teachers and students, the two major links in the educational chain.

Educational Digital Library Module

The main function of the educational digital library module is the dynamic construction and presentation of collections of educational materials, commonly known as learning objects. The system gives teachers the ability to build such collections with effective full-text searching and metadata-based browsing facilities that are attractive and easy to use. Moreover, they are easily maintained and can be enriched and administered in a semi-automatic way.

A learning object is any digital entity, which can be used, reused or referenced during a learning activity (LOM). It can be text, pictures, or other multimedia formats. The application collects learning objects and semantic information about them using a number of metadata. As mentioned above, in order to ensure the desired semantic interoperability, the standardized Dublin Core Metadata Element Set is being used. According to this set, metadata such as author, title, description, date, keywords, category and technical features (resource

size and format) are associated with each learning object. These are the raw material for indexes and are used to support searching and browsing facilities. They are explicitly provided by the contributor who completes the corresponding forms.

Searching utilizes indexes from the above metadata such as title, description, author names of learning objects and also category title and keywords, the selection of which is used to create expanded queries. The search interface is a simple one, suitable for casual and advanced users. It allows term and phrase searching and also stemming control.

Browsing utilizes metadata such as category title and subject. Users when browsing, examine a dynamic hierarchical classification scheme, in the form of a tree structure, created by these metadata. Each learning object is classified into the categories and subcategories of this scheme (Fig. 1). Browsing is particularly helpful for inexperienced users not familiar with a subject, its structure and terminology (Koch et al., 1999).

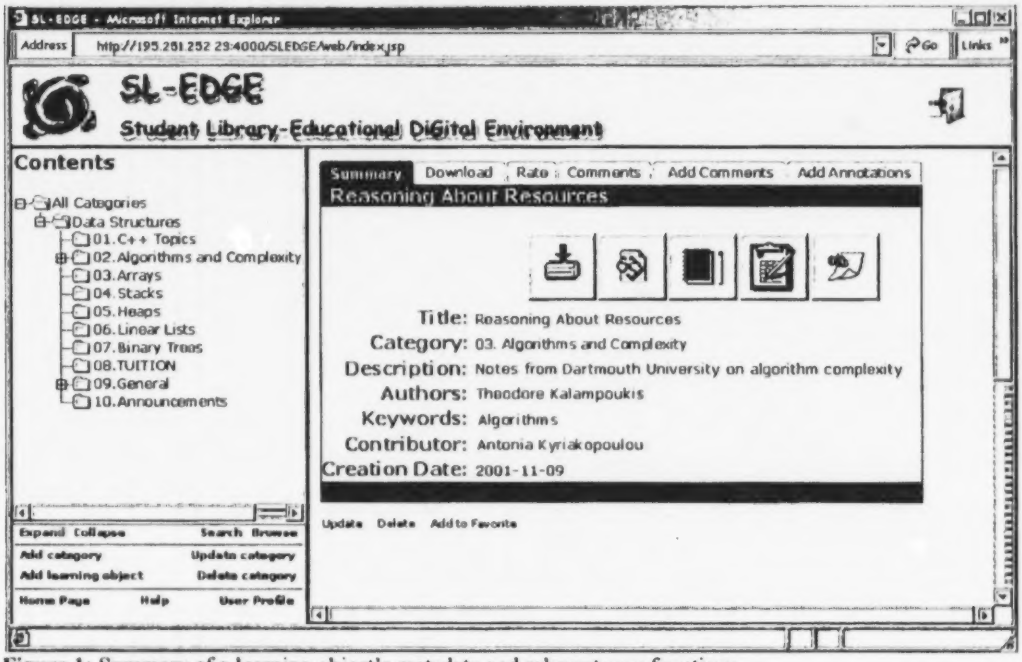

Figure 1: Summary of a learning object's metadata and relevant user functions

The result from searching or browsing is a number of learning objects. In case of searching, the retrieved learning objects are displayed ranked according to the number of occurances of the search terms in the metadata records. In case of browsing, the system retrieves the learning objects that are classified under the category selected by the user and under the children-categories by traversing the branches of the tree structure. The displayed learning objects are sorted by metrics related to their popularity, i.e. their visiting rate.

The selection of a learning object displays the summary of metadata associated with it (Fig. 1), and gives the user the ability to add it to "My Favorites", to view and reply to existing comments or create new ones, to create personal annotations and to download the resource to his/her system. Last but not least, the user can rate the learning object using a Likert scale from 1 (minimum) to 5 (maximum), and can also find relative statistical evidence such as the total number of users who have rated it, the percentage of users who have rated it at each point of the scale, and the average attained variation.

The above capabilities and information create what we call "user profile" for each user (Fig. 2). This contains information about the user (name, surname, e-mail, etc.), links to "My Favorites", replies to comments created by him/her and corresponding personal annotations. The most important aspect of a user profile is that it captures non-visual information concerning the learning objects visited by the user and the rates awarded.

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A suitable collaborative filtering algorithm based on the approach of the "nearest-neighbor" (Recker & Wiley, 2000) further exploits the above information about the users and their preferences. This particular approach concerns the selection of a subset of users according to their similarities in certain parameters. Specifically, users with high correlation in relation to their rating of the same learning objects are treated as having the same interests and they construct the so-called user's "active neighborhood". After the creation of the user's active neighbor, the learning objects that have received high marks from the users of the neighborhood are recommended to him/her as relevant learning objects. In this way, the approach supports the automatic recommendation of relevant learning objects and allows the user to locate other users with whom shares similar interests for further communication and collaboration. The result of the above procedure is the creation of communities through evaluating and using learning objects, as well as the reinforcement of the reusability of the learning objects.

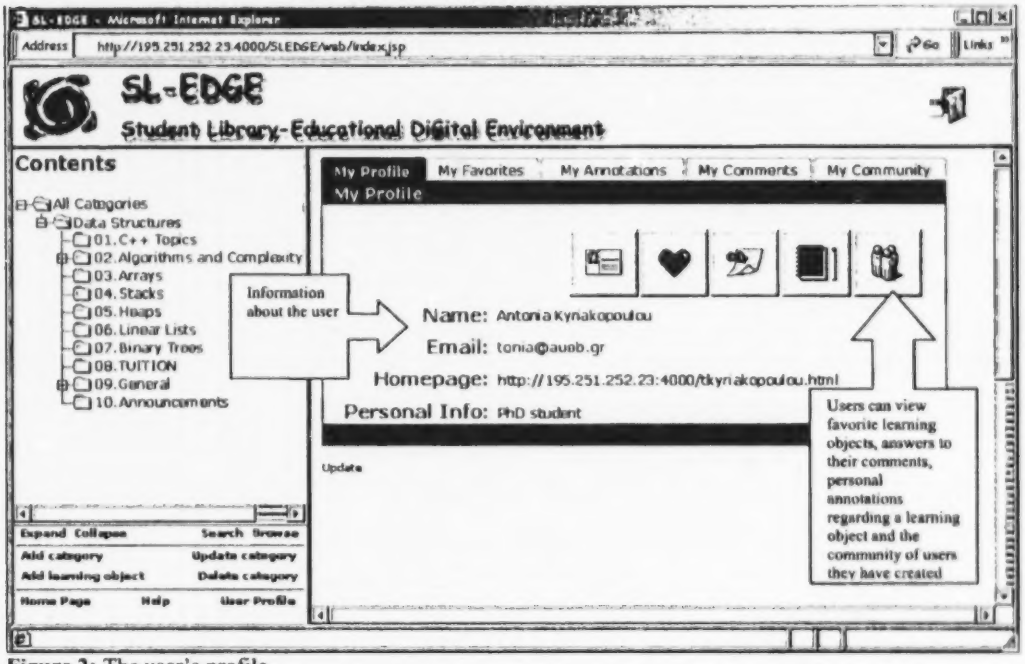

Figure 2: The user's profile

The system also includes an "administrative" function whereby users with administrative privileges can register new users and also manage the classification scheme and the collection of the application by inserting, updating and removing categories, subcategories, learning objects, authors and keywords. The interface of the application appropriately supports these functions. The module has many automatic features allowing simple, novice users to use it and make the most of it.

Assessment Module

The assessment module provides two interfaces, one for the teacher and one for the student, with appropriate functionalities and capabilities. Specifically, the teacher creates questions, constructs assessments and tests from sets of questions, assigns them to particular students or groups of students, reviews results and sees statistics and other evidence of comprehension and progress. The student on the other hand, sits for the test online on dates that have been set by the teacher and sees the automatically generated (where possible) results. The results are presented in various ways (graphically, etc) and the student can also see the right answers to the

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tests already taken and any available feedback given by the teacher. Last but not least, the system lets the students keep track of their progress and compare their overall performance with that of their classmates.

Going into details, the process of constructing an assessment includes a set of steps. First, the teacher creates the questions of the test. The types of questions currently supported by SL-EDGE are (Fig. 3):

- Multiple choice
- True/False
- Fill in the blanks
- Open-ended

The process of creating a question includes composing the question itself, the possible answers, the right answer(s) and the marks that will be added to the student's final score if answered correctly. Also, the teacher has the option to add feedback to each question to be supplied to the student after test completion. According to the type of question selected, a corresponding form with appropriate guidelines is presented to the teacher to fill in. After being created, the question is submitted to the central point of the module, the question pool. Assessments and tests are created by drawing questions from the question pool (Fig. 3). The teacher can choose from the new questions that he/she has submitted following the procedure discussed above, and/or from the already existing questions. This means that a question can be used for the construction of various tests, something that is in favor of reusability, achieving minimum authoring time and maximum flexibility. An assessment consists of an open-number of questions and also includes information such as title, date of fulfillment and guidelines for the students. Assessments can be viewed from the corresponding assessment pool.

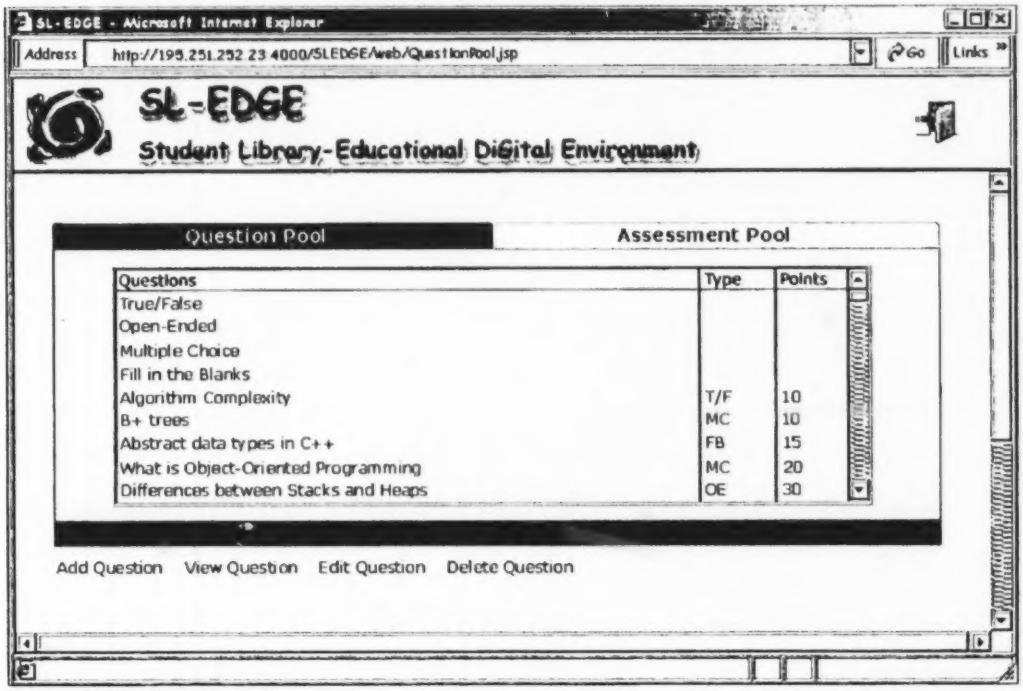

Figure 3: The Question Pool

All assessments can be removed or updated by adding or removing questions and updating related information. Accordingly, questions can be removed and updated too. These functions require that their executor is indeed the creator of the assessment and/or question. The deletion of a test doesn't lead to deletion of the questions that form it; questions that are included in assessments cannot be erased.

The teacher's interface also includes a mechanism for receiving and evaluating the answers to the open-ended questions that a test might have and for sending back the corresponding scores.

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The student's interface is where the tests are taken. All questions of a test are presented in the appropriate format. The student can navigate back and forth the questions and give his/her answers. Immediately on completion, the results are automatically extracted along with the right answers and the feedback supplied by the teacher. Only open-ended questions are sent back to the teacher for review and evaluation.

Both interfaces include a mechanism for viewing the results of the tests and keep track of the progress. The system provides for the creation of reports of progress in many formats (charts, graphical representations, etc).

In conclusion, the assessment module provides an automated, wizard-like environment for the creation of questions, the construction of a test and its assignment to specific students or groups of students and the review and extraction of results after its completion.

System's Architecture and Technical Features

The system follows the 3-tier architecture model with a relational database for the data storage layer, Java, JavaBeans and JavaServer Pages (JSP) for the application layer and HTML and JavaScript for the presentation layer.

Also, the system adopts the Struts framework for building Web applications that integrates with standard technologies like the ones mentioned above. This encourages application architectures based on the Model-View-Controller design paradigm (Struts).

Last but not least, the Unicode character set is used throughout so that learning objects, tests and interfaces can be in any language. Learning objects and tests have been produced in English and Greek, and SL-EDGE has interfaces in both languages.

Conclusions and Further Research

The increase of the available information on the World Wide Web and the penetration of web technologies into the educational sector have led to an imperative need and an absolute requirement for the development of tools that will support effective searching and indexing capabilities and will offer rich environments for the uplift of the learning process together with a knowledge management potentiality.

Digital libraries are good examples of the investigation and research of new approaches related to the effective use of huge information repositories, due to the tradition shared by the simple conventional libraries on supporting the information needs of their users. The digital library module of SL-EDGE incorporates a variety of technologies that provide consolidation, organization and access capabilities on large information volumes and presents heterogeneous information resources distributed over the Internet to look like a unified, homogeneous and integrated information resource. The system not only successfully supports the storage of learning resources but also the systematic knowledge acquisition related to its content and the user's preferences and behavior.

The use of metadata for the description of the classification scheme and the learning objects provides adequate support for the searching and browsing mechanisms. The metadata records created, describe in a successful way the educational context in which a learning object is to be used, reused or referenced. Also, the standardized Dublin Core Metadata Element Set adopted ensures the desired syntactic and semantic interoperability. This particular set has turned out to be simple but adequate for the library's needs; it is now one of the most popular and well-known standards and is given great support from the market (DC projects)(DC tools). To eliminate the time consuming procedure of metadata creation for each learning object, we only used a subset of the DCMES for the administration of our collection. The use of a number of automated forms with pop-up windows, drop-down lists, etc. optimized the process.

The implementation of the collaborative filtering approach adds a knowledge management view to the content and the library that derives from recording and further analyzing the user's "behavior". The approach manages to support the automatic recommendation of relevant learning objects and gives to the user the ability to locate other users with whom shares the same interests for further communication and collaboration. The result of the above procedure is the creation of communities through using and evaluating the learning objects of the collection and also the increase of the reusability of learning objects. However, for the further

exploitation of this capability we suggest that in the future the system should provide a mechanism that will give greater motivation to the users in order to rate the learning objects they visit and provide more feedback for the collaborative filtering approach (Jones, 2001).

As far as the assessment module is concerned, this tool has succeeded beyond our expectations. It has been proved easy to use and manage for both teachers and students, optimizing the assessment procedure in all its phases, from the creation of a test until its final evaluation. The preparation time has been minimized by the ability of reusing already existing questions and tests whereas the wizard-like environment permits even casual users make the most of it.

Further research encompasses fundamental issues surrounding the concept of ontologies and knowledge acquisition. An ontology can be used to describe a piece of reality; it is referred to as "a specification of a conceptualization" (Uschold, 1996)(Uschold & Grüninger, 1996). It is typically conceived and expressed as a set of concepts (for example entities, attributes and processes), their definitions and their inter-relationships (RichODL-OU-3/1999). In the next version of SL-EDGE we are planning on creating an ontology that will describe the educational domain and will maximize the results from the use of the techniques and methods described above. In particular, we are concerned with how to incorporate the concepts of personalization and adaptability to the users' needs into the services offered by our application.

Another future extension of SL-EDGE is the development and integration of digital portfolios. Research up to now, has revealed that digital portfolios' main purpose is to constitute an alternative way of assessing students' progress by storing their scores and other material results. This information is then used as evidence of the learning acquisition and outcome. However, we believe that digital portfolios can be of wider use than just used for the assessment of the students' progress. If we approach digital portfolios from a knowledge management point of view, the results that they contain can be shared and distributed over the intranet and/or the Internet (Tillema, 1998).

SL-EDGE has been being used for over six months as a pilot program hosting learning resources from the courses of "Data Structures" and "Information Retrieval Systems" held in the department of Informatics in our University. The users registered are students that attend the courses and reach the number of 150. These are the simple users of the application with capabilities of searching and browsing learning objects and conducting assessments. Also, there is a number of users registered that play the role of the authors and/or contributors of the learning objects and that of the creators of the assessments. These are the professors of the courses and the assistants conducting the corresponding tuitions. Until now, up to 70 learning objects appropriately described with metadata records have been inserted and three assessments per course have been conducted. The general feelings we received from the users were very encouraging since they remarked on an increase of productivity and a very easy adaptation to the features and functions of SL-EDGE. Also, its property for keeping track of progress turned out to be very helpful.

We believe that the capabilities, techniques and user services presented in this paper contribute to the success of an application like SL-EDGE, which constitutes a useful and essential tool for tutors and learners.

SL-EDGE official site:
http://195.251.252.23:4000/SLEDGE/web/CheckCredentials.jsp

References

ADL. *Advanced Distributed Learning*. http://www.adlnet.org/

ARIADNE version 3.1. *ARIADNE version 3.1 Educational Metadata Recommendation, May 2001*. EPFL (Lausanne, CH), K.U.Leuven (Leuven, B) and the ARIADNE Foundation, http://www.ariadne-eu.org/3_MD/ariadne_metadata_v31. htm

ARIADNE. *Alliance of Remote Instructional Authoring and Distribution Networks for Europe*. http://ariadne.unil.ch/

Baker, T. (2000). A Grammar for Dublin Core. *D-Lib Magazine*, Vol. 6, No 10, October 2000.

CEN/ISSS. *European Committee for Standardization/Information Society Standardization System*. http ://www.cenorm.be/isss/Workshop/LT

DC projects. *Dublin Core Projects*. http://dublincore.org/projects/

DC tools. *Dublin Core Tools and Software*. http://dublincore.org/tools/

DCMES. *Dublin Core Metadata Element Set*. http://www.dublincore.org/documents/dces/

DCMI. *Dublin Core Metadata Initiative*. http://www.dublincore.org/

DLI. *Digital Libraries Initiative Project at the University of Illinois*. http://www.canis.uiuc.edu/news/ieee_2_99.html

Dong, A., Agogimo, A.M. (2001). Design Principles for the Information Architecture of a SMET Education Digital Library. *Proceedings of the 2001 ACM/IEEE Joint Conference on Digital Libraries JCDL '01*, June 24-28, 2001, Roanoke, VA, USA, New York, New York: The Association for Computing Machinery, 314-321.

IEEE. *IEEE Learning Technology Standardization Committee (LTSC)*. http://ltsc.ieee.org/

IMS. *IMS Global Learning Consortium*. http://imsproject.org/

Jones, P. (2001). Open(source)ing the doors for contributor-run digital libraries. *Communications of the ACM*, Vol 44, No 5, 2001.

JSP. *JavaServer Pages*. http://java.sun.com/products/jsp/

JTC1. *ISO/IEC JTC1 Joint Technical Committee*. http://www.jtc1.org/

Koch, T., Zettergren, A.S., Day, M. (1999). Provide browsing using classification schemes. *EU Project DESIRE II*. http://www.lub.lu.se/desire/handbook/class.html

LOM. *IEEE Learning Object Metadata*. http://ltsc.ieee.org/doc/wg12/scheme.html

LSC. *Libraries Special Collections Project at North Carolina State University*. http://www.lib.ncsu.edu/archives/tech_serv/cad.html

Fullerton, K., Greenberg, J., McClure, M., Rasmussen, E., Stewart, D. (1999). A digital library for education: the PEN-DOR project. *The Electronic Library*, Vol. 17, No. 2, pp. 75-82, April 1999

Recker, M.M., Wiley, D.A. (2000). A non-authoritative educational metadata ontology for filtering and recommending learning objects. *Journal of Interactive Learning Environments: Special issue on metadata*, September 2000.

RichODL-OU-3/1999. Introduction to Ontologies. *RichODL-OU-3/1999*, September 1999.

Roes, H. (2001). Digital libraries and education: trends and opportunities. *D-Lib Magazine*, July/August 2001.

SC36. *ISO/IEC JTC1 SC36*. http://jtc1sc36.org/

SCORM. *Sharable Content Object Reference Model*. http://www.adlnet.org/Scorm/scorm.cfm

Struts. *Struts Framework*. http://jakarta.apache.org/struts/

Tillema, H.H. (1998). Design and validity of a portfolio instrument for professional training. *Studies in Educational Evaluation*, Vol. 24, No 3, 1998.

Uschold, M. (1996). Building Ontologies: Towards a Unified Methodology. *Proceedings of Expert Systems '96, the 16th Annual Conference of the British Computer Society Specialist Group on Expert Systems*, Cambridge, UK, 16-18 December 1996.

Uschold, M., Grüninger, M. (1996). ONTOLOGIES: Principles, Methods and Applications. *Knowledge Engineering Review*. Vol. 11, No 2, June 1996.

Witten,I.H, Bainbridge, D., Boddie, S.J. (2001). Greenstone. Open-Source Digital Library Software. *Communications of the ACM*, Vol.44, No 2, May 2001.

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